

The Planets

The following questions were answered by astronomer Dr. Cathy Imhoff of the Space Telescope Science Institute.

Do all the planets have seasons? What causes seasons? Earth is tilted with respect to its orbit around the sun. So when our North Pole is tilted toward the sun, we get summer in the Northern Hemisphere (winter in the south). When the South Pole is tilted toward the sun, we get winter.

So if a planet is tilted with respect to its orbit around the sun, it should have seasons. Here are the numbers that I was able to find this morning (as of September 1994) Venus — 23 degrees tilt, Earth — 23.5, Mars — 24, Jupiter — 3, Saturn — 27, Uranus — 98, Neptune — 29.

But you can see that most of the planets have tilts like Earth, so they must have seasons. As I noted above, we definitely see seasons on Mars. In winter its ice caps grow, in summer they shrink. Jupiter has very little tilt, so it doesn't experience noticeable seasons. But Neptune is turned all the way over on its side! It must have very strange seasons!

How did the planets get their names? Five of the planets were known to people thousands of years ago. They are bright enough to be seen with the naked eye and they move with respect to the stars. The name *planet* comes from the Greek word for "wanderer."

I'm sure that people in different lands had various names for them, but the names we use come from the ancient Greeks and Romans. They named the planets for some of their gods. Mercury was the Roman god of commerce and cunning, and also messenger to the gods. Venus was the goddess of love. Mars was the god of war. Jupiter was the chief god. Saturn was the god of agriculture.

When the next planet was found by Sir William Herschel in 1781, there was quite a debate about what to name it. Finally everyone decided to stay with the Roman names from mythology. So the new planet was finally named Uranus, for the father of the Titans. The next planet was named Neptune, for the god of the seas. And Pluto was named for the god of the underworld. Most of the moons and some asteroids are also named from Roman mythology.

What was the first planet discovered? Who discovered it? What kind of equipment did they use? Five planets have been known since ancient times — Mercury, Venus, Mars, Jupiter, and Saturn. The first new planet discovered was Uranus. It was discovered by the English astronomer Sir William Herschel in 1781.

Herschel was one of the first modern astronomers. His patron was King George III of England (the same King George from the time of the American Revolution!). Herschel wanted to name the planet after King George, but nobody else liked that so they gave it the name Uranus.

Herschel and his sister Charlotte (who was an astronomer in her own right) used several

reflecting telescopes, some of the first based on a design invented by Sir Isaac Newton. The largest was over 40 feet long and had a mirror 48 inches across. It was held up with a framework of wood, and they had to have helpers move it around using ropes and pulleys. It was the largest telescope in the world until over 100 years later.

Which planet was formed first and how was it formed? We think that the planets all formed pretty much at the same time. However the sun probably formed first. The leftover gas and dust remained in a disk around the sun. In this disk, stuff began to clump and form "planetesimals" (pronounced pla-ne-TE-si-mals). These are small rocky bodies, something like asteroids. They crashed into each other and eventually formed the inner planets.

At the same time, planetesimals formed the cores of the outer planets Jupiter and Saturn. Because of their strong gravity, they swept up a lot of gas. Uranus and Neptune did this too, but there was less gas around because Jupiter and Saturn got it first. The asteroid belt may be left-over planetesimals that never formed a planet because Jupiter's strong gravity nearby kept it from forming.

Are there any living things on any of the planets? So far we know of only one planet with life — Earth! In 1976, we landed probes on Mars that looked carefully for evidence of life. But they couldn't find any.

The other planets are less likely to have life (at least life like that on Earth) because they are too cold, too hot, don't have water or air. So as far as we know, Earth is alone in this solar system in having life.

Why are all planets round? Planets and stars are round because of gravity. Gravity pulls equally in all directions. Suppose you had a great big, tall mountain. As time goes by, rocks and dirt loosen up and fall down the mountain side. Eventually the mountain is worn down. Similarly a deep, deep valley will fill up. Of course a planet is not perfectly round — look at the mountains and valleys on the Earth and on Mars!

Also the bigger the planet, the stronger the gravity. So bigger planets will be rounder. Tiny planets may not be very round. For instance, some of the moons around Jupiter are not very big and are not round — sort of oblong and irregular. Asteroids, which may be only a few miles long, are also irregular.

Why does every planet have gravity? Every planet has gravity, because EVERYTHING has gravity! Even you do! All matter in the universe has gravity. The bigger something is, the more gravity it has. The earth has strong gravity, but the sun is much bigger and has much stronger gravity. You also have gravity much, much, much smaller than the earth, so your gravity is very small. That's good or else things would be sticking to you!

Why do some planets have more gravity than others? The strength of gravity depends on two things, the mass of the planet and how far we are from the center of the planet. So the gravity we would experience standing on the surface of a planet depends on how massive the planet is (the heavier the planet, the more gravity) and how big the planet is (the bigger the planet, the further we are standing from the center, and thus the gravity is less).

Most of the planets in our solar system are more massive than Earth, but they are also larger, so you have to do the calculations to figure out how the surface gravity compares.

How did the planets get the energy to rotate? Actually in space it is hard to get something to NOT rotate!

The planets were formed from the same big cloud of gas and dust that formed the sun. That cloud, as it collapsed and started to form the sun, spun faster and faster as it got smaller. That is the way spin works — something that scientists call "conservation of angular momentum." A familiar example is an ice skater. The ice skater starts to spin, and when she pulls her arms close around her the spin goes faster. You can do the same thing on a chair that lets you spin. Push yourself into a spin with your arms and legs stuck out. Then pull your arms and legs in to your body. Your chair will spin faster!

Well the same thing happened to the cloud that formed the sun (which is spinning) and to the portions of the cloud that formed the planets. As their smaller clouds collapsed, they spun faster and faster.

Could planets come together to form one large planet? When our solar system was forming, many small "planets" did collide to make bigger planets. But this stopped and as a result we have our current collection of planets. Their orbits are all very stable and they can't collide now.

What are the relative distances of each of the planets from the sun? How long does it take for each of the planets to orbit the sun? Also, please provide any other data regarding the weight and such. Let's see if I can put the information into a table to help you to better understand:

PLANET	DIST. FROM SUN (A.U.)	ORBIT PERIOD (EARTH-YEARS)
Mercury	0.387	0.241
Venus	0.723	0.615
Earth	1.000	1.000
Mars	1.524	1.881
Jupiter	5.203	11.86
Saturn	9.555	29.46
Uranus	19.22	84.01
Neptune	30.11	164.79
Pluto	39.44	248.5

NOTES: DIST. FROM SUN is in Astronomical Units (A.U.), which is the distance between Earth and the sun, or 93,000,000 miles. ORBIT PERIOD is in Earth years. This is length of time for the planet to circle the sun, so this is the planet's "year."

PLANET	MASS	RADIUS	SURFACE GRAVITY (g)
Mercury	0.0558	0.381	0.38
Venus	0.815	0.951	0.90
Earth	1.000	1.000	1.00
Mars	0.107	0.531	0.38
Jupiter	317.89	10.85	2.64
Saturn	95.184	8.99	1.13
Uranus	14.536	3.96	0.89
Neptune	17.148	3.85	1.13
Pluto	0.0022	0.18	0.06

NOTES: MASS, RADIUS, and SURFACE GRAVITY are all compared to Earth. Earth's radius is about 3,800 miles. If you could weigh Earth, it would weigh 13,000,000,000,000,000,000,000..... (24 zeros) pounds! Whoa! That's heavy!

Do the weights of planets stay the same? Pretty much. Over millions of years, they pick up some space dust but that's very little compared to how much they weigh to start with.

Can you tell if a comet crash is going to hit a planet before it happens? If we know about the comet and observe it, we can compute its orbit. Some astronomers specialize in big computer programs that can predict the orbits of the planets, comets, etc. So they can predict such a comet crash. That is what they did when Comet Shoemaker-Levy 9 was discovered — they showed that it was going to hit Jupiter. Small asteroids are harder, because they aren't as bright as comets. They are just "rocks," not glowing gases like the comets. About once every 10 years we hear about some small asteroid that whizzed by the Earth and no one knew about it until just before or after it whizzed by. But the chance of one actually hitting Earth is still very very small. Thank goodness!

Why are there nine planets? Instead of eight or ten? As far as I know, there is no special reason.

Do the planets ever get smaller by melting and erosion? Melting and erosion must occur on other planets. For instance, Mars has ice caps, and the surface shows channels where water or something once flowed. Also we see dust storms. But do planets get smaller? I don't think so. Think about Earth — ice may melt and rocks erode, but that just moves stuff (water, sand) around on the surface. To make the planet get smaller, stuff would actually have to leave the planet! Gravity makes sure that it doesn't.

Is there pollution on any of the planets? By pollution, we usually mean something man-made that doesn't belong there. I guess you could say that we have polluted the moon, Mars, and Venus, because we sent satellites and probes to them and just left them there when we were done with them! Hopefully when the astronauts visited the moon, they cleaned up their Coke cans and orange peels before they flew back to Earth.

Have scientists found any microscopic organisms that live on any (other) planet? The only place we have looked thoroughly is Mars, and nothing was found. Some people think that if we check closer to the ice caps, where there is more water, there might be a better chance. Hopefully some day we will do that.

Do you have any new information on the new planets? Actually, there are now several stars that we know are planets. The first to be discovered was 51 Pegasi, but there are now five more stars similar to our sun that have at least one planet. The biggest planets are the easiest to find, so it's not surprising that all the planets found so far are around the size of Jupiter, our biggest planet. If you would like to read more details about these new planets around other stars, you can try the planet search Web page at <http://www.physics.sfsu.edu/~gmarcy/planetsearch/planetsearch.html>.

Why do planets rotate on their axes? Well, it turns out that there is a lot of "spin" in the universe (a scientist would call it "angular momentum"). Everywhere you look planets, stars, and galaxies are spinning. It's hard to find something that isn't spinning! The planets are rotating because when they were formed, the cloud of gas and dust surrounding the young sun was circling it in orbit. Small icy, rocky "lumps" formed in this cloud and swept up smaller particles and gas. These clumps began to form planets.

As the rocks, ice, and such fell onto these new planets they helped to keep them spinning. The planets closest to the sun, however, don't rotate as fast as they did when they were formed. The sun's gravity has slowed them down. Mercury and Venus both rotate rather slowly. Earth's gravity slowed the rotation of the moon, which is why now it always keeps one side to Earth.

When do you think that humans will be starting to live on other planets? In your lifetime, we should be able to start small colonies on the moon and on Mars. It will be hard for them to be entirely self-sufficient though. It would be very hard to live on any of the other planets in our solar system. We might put small scientific stations on one of Jupiter's moons or in orbit around Jupiter or Saturn. But good old Earth is the only place where life can prosper.

Have there been any newly discovered planets? Recently there has been a planet discovered around a star named 51 Pegasi. This is a naked-eye star in the constellation Pegasus. We are particularly excited about this because the star is fairly similar to our sun. But the planet is nothing like the planets in our solar system. It is big — about half the size of Jupiter — but VERY close to the star. It must be very hot on that planet, and it must be made of rock and metal (not gases like Jupiter) in order to survive so close to the star. Some people have suggested that we name the planet Vulcan!

Why do different planets have more moons? For planets, the bigger you are, the bigger your gravity is. If you have stronger gravity, then you can grab onto more moons. Jupiter and Saturn are the biggest planets, so they have the most moons.

How many moons do each of the planets in our solar system have? Here are the moons that we know of. There may be more small moons around Jupiter, Saturn, Uranus, and Neptune that haven't been seen yet. Mercury — 0 moons Venus — 0 Earth — 1 Mars — 2 Jupiter — 16 Saturn — 18 Uranus — 15 Neptune — 8 Pluto — 1

Do scientists think there might be a tenth planet in our solar system? For some time, astronomers have tried various ways to search for a tenth planet. But we now think that there are no new planets. One big reason is that the Infrared Astronomy Satellite, known as IRAS, did a very good map of the sky in infrared light. If any new planet were out there, IRAS should have found it. But it didn't. So we think that there are no more planets in our solar system.

Are there any more planets in the galaxy? We think so. Our sun is a pretty typical star, and we are guessing that many stars have planets. So far we have found only a handful of planets around other stars. Planets are small and dim compared to their stars, and that makes them hard to find.

Is there another planet like ours? The planet (which we know of) that is most similar to Earth is Mars. As you probably know, Mars is smaller, colder, and has less atmosphere. But it does seem to have some water (mostly ice) and on a really hot day can get to 80° Fahrenheit.

Have there ever been any other planets that dinosaurs could have survived on? I don't think so, at least for any of the planets in our solar system. Mars may have had some liquid water millions of years ago, and life might have started. But the atmosphere is too thin and too cold for life to have evolved very far. Venus is a horrible hothouse with acid rain. Mercury is terribly hot. Jupiter and the other planets are way too cold. Of course there could be another planet circling another star where life exists. But we don't know enough about those other planets yet to even say how many there are, much less whether dinosaurs (or people) could live there. But the universe is a very big place. I believe that there are living creatures out there somewhere!

How do planets stay in orbit? The sun's gravity holds all the planets in orbit. Their orbits are a balance between gravity and the motion of the planet (if the planet wasn't moving, it would fall into the sun!).

If the planets all lined up what would it be called? We would call it a planetary alignment. When a planet lines up with the sun and Earth, and the planet is closer to the sun than Earth is, we call it a conjunction. If a planet lines up with the sun and Earth and the planet is farther from the sun than Earth, we call it opposition. There is also a cool word that isn't used very often except in crossword puzzles — syzygy (siz-i-gee) — which means any alignment of three bodies (sun, earth, moon, planet, whatever). How many words do you know that have three Y's in them?

Will we ever be able to travel to another planet? Astronauts have walked on the moon. We have sent out spacecraft all over our solar system. So I think that within the next 20 or so years we will have people visit Mars. NASA has been working on how to do that for many years. But it is a big, difficult undertaking.

Why doesn't gravity pull the planets into the sun? One approach is to go back to Sir Isaac Newton's reasoning — the famous apple falling from a tree event. This story may not be true but it is probably not far from how he came up with the ideas of gravity and motion. Newton asked himself — why doesn't the moon fall to Earth, the way the apple falls from the tree? He reasoned that the motion of the moon around Earth had something to do with it. Suppose you threw the apple very hard. It would fall to earth, but not at the same spot. Suppose you could throw the apple so hard that it never fell to earth. It would keep circling Earth, just as the moon does.

Similarly Earth's motion in its orbit keeps it from falling into the sun. On the other hand, the moon can't escape from Earth (or Earth from the sun) because of gravity. I haven't tried it but you could try magnets. Two magnets at rest will pull together, but if you slide one past the other fast enough they won't stick. It would probably be hard to get them to "orbit" each other!

Have people found other solar systems with life on the planets? So far no, we have not found life anywhere but on Earth. We are also having a hard time finding planets around other stars. The problems are first, distances are so great. Second, the star is very much brighter than any planet would be.

How do the gaseous planets get their gases? Most of the "stuff" in the universe is gas. When our solar system formed, it was mostly gas with some dust. Earth was probably surrounded by gases. But Mercury, Venus, Earth, and Mars were all too close to the sun to hang onto most of their gases. The gases were heated or blown away. So those planets are rocky, with only thin gas atmospheres. The outer planets were far enough away from the sun that they held onto their gases. Even so they lost most of their lightest gases like hydrogen.

How do gas planets stay together? How can gas have gravity? All matter, whether it is solid, liquid, or gas, has gravity. So the gas planets stay together because of the planets' gravity.

How did planets get their rings? We think that small moons, or maybe comets, get too close to the planet. Then its gravity tears them apart. The bits of rock and ice then go into orbit around the planet and make rings. Some people think that Earth may have rings at one time!

The ringed planets are next to each other. Is there a reason for that? A very good question! I think that the planets that are closest to the sun, Mercury and Venus, don't have rings (or moons!) in part because the sun's gravity would pull them apart. Earth may have had rings in the past, but I think our moon's gravity would pull them apart.

Mars might have had rings but the big planet Jupiter would probably pull them apart. The big outer planets — Jupiter, Saturn, Uranus, Neptune — all are big enough to have strong gravity to hold onto their rings. Also they are further from the sun and from each other. Pluto has a big moon, Charon, that would probably pull apart rings.

What are the colors of all the planets? This is a really good question! Most of the planets don't have bright colors, so often the pictures have been "enhanced" or shown in "false colors" using computers to bring out the details. So in some of the pictures the colors you see are not be real. Here are the planets' colors as I understand them. Mercury is bare rock, a light gray color, like the moon.

Venus' clouds are yellowish-white. (There is a famous picture of Venus that looks dark blue and white — it is a "false color" picture that was actually taken in ultraviolet light to show the cloud patterns. I've also seen the same picture showing the clouds as light tan!) Earth is largely covered by water and there are lots of clouds, so it looks mostly blue and white. Mars really is red, a rusty orange-red color.

Jupiter's clouds look yellowish white if you just look at it in the sky or through a telescope. True color pictures from Voyager show that some of the clouds look light brown and light orange. Many of the published pictures of Jupiter have been color enhanced to show the details in the clouds and the Red Spot (which is orangish-red). Saturn also looks yellowish-white. Its colors are similar to Jupiter's but not as strong.

Uranus and Neptune look pale greenish-blue. Many of the pictures I have seen of them have the colors made stronger (bluer) than they really are. There aren't any detailed photos of Pluto yet, but it looks pretty much just white. This is reasonable since its surface is mostly ice.

If it were possible to put a colony of people on a planet with greater gravitational pull than Earth's, would there be a way to compensate for the greater force by using mechanical means? I wonder about the physical strain of living under 2 g (two times earth gravity) for example. We know that jet pilots who undergo high gravity experience certain physiological effects, including problems with blood pooling in their feet and away from their brains, and thus sometimes falling unconscious. They wear special pressure suits to help counteract that effect. These are sort of like elastic pants that help force the blood back up into the upper body.

What planet is brightest in the skies in the morning? Venus is the bright object closest to the horizon in the east at dawn. It is brighter than any star, so it's pretty recognizable. Jupiter is also in the east, not quite as bright as Venus and further from the horizon. In late January early February Jupiter lies fairly close to a bright red star, Antares. Antares is the brightest star in the constellation. By the way, Saturn is low in the west in the evening sky. Mars is near opposition (i.e. opposite the sun) so it rises in the east around sunset. It is noticeably red and lies near the sickle shape part of the constellation Leo.

Are there planets around Vega? There is a disk of dusty material around Vega. I don't think anyone has found planets there. But planets are hard to find, so there might be planets that we can't see.

Referenced from scholastic website